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Illumination Inconsistency Sleuthing for Exposing Fauxtography and Uncovering Composition Telltales in Digital Images

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Abstract

Think about how capture device's technology is improved day after day. Add to this condition that digital image manipulation tools are increasingly powerful and simple to use. Finally, when a malicious user is added at this equation, the result is an astonishing number of digital images forgeries spread out in the internet as fast as possible. Cases as the fake dead of Ozama Bin Laden or the fake criminal record of Brazilian current president Dilma Rousseff [1] are just a few examples of how digital images forgeries can be malicious and dangerous.

In special, image *splicing** is a very usual kind of image forgery. It consists in use parts of two or more images to compose a new one depicting a moment that never happen. Figure 1 depicts an overview of image splicing creation process.

For helping forensics community to fight, specifically, against this kind of digital image forgeries, this work† present a collection of four different methods for detecting forgeries created by image composition. Given that human are not quiet reliable to detect illumination inconsistencies in images [2], which makes a perfect illumination matching almost impossible to achieve when creating images compositions, our methods look for this kind of inconsistencies to detect if some image is, or not, an splicing.

In our first proposed method [4], we use eye specular highlights to detect image compositions. To perform this task, proposed method is able to estimate two important informations: (1) 2-D light source direction and (2) 2-D viewer (camera) direction. We combine this two informations with a machine learning algorithm to detect forgeries. As result, our method decrease state-of-the-art error in forgeries detection in more than 21%.

As a second contribution [5], we proposed a method for exploring illuminants properties. Estimating illuminant colors using different approaches, our method characterize illuminants of faces using texture and edges properties. These features are used as input for a meta-learning process of SVM classifiers getting an accuracy of 79% in fake image detection.

Incrementally, in our third contribution [6], a direct improvement of our second approach, we explore additional features not explored before. Using 54 different ways of characterize illuminants of faces, and an efficient

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*Image splicing is also known as image *composition*

†http://ic.unicamp.br/~tjose/publications/phd-thesis.pdf

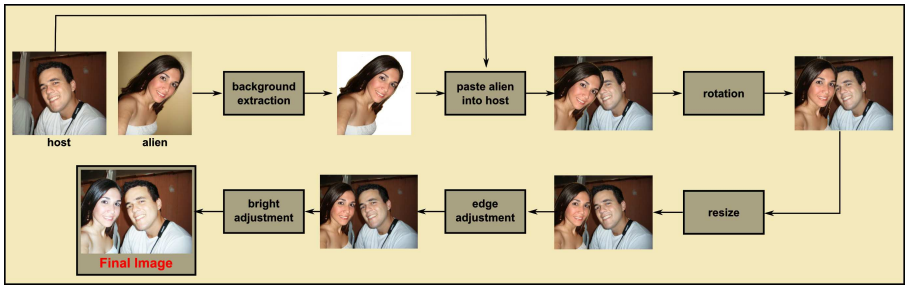

Figure 1: Overview of image splicing creation process. Source: Carvalho et. al. [3]

machine learning fusion method based on features correlation, we improve our accuracy from 79% to 94% in fake image detection process. Additionally, at this work we also propose an approach to detect the face with bigger probability of been the fake face.

Finally, in our last contribution [7], we propose a method to be used in a more general scenario[‡]. Based on a previously work [8] which shows that people are reasonably good to estimate 3-D normals from 2-D images, we propose a method that use these 3-D user's input normals to estimate 3-D light source position from a 2-D image. Assuming that the only error in 3-D estimated position is provided by the user, we also propose a correction process to get a more precise position of 3-D light source.

Along this Ph.D. thesis, we have proposed different methods to detect image composition, always exploring illumination inconsistencies. Despite each one of proposed methods provide a big number of scientific contributions in digital forensics, computer vision and image processing areas, we conclude that there is no *silver bullet* for this kind of problem. All the methods work complementarily to help forensics expertises to take the better decision.

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[‡]All three previously methods just can be used to detect image composition involving people